Space Weather Technical Forecast

Issued on Monday, 24 July 2023 at 13:23 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance R1/R2 blackouts throughout. Chance of G1 late day 3 into day 4 (26th/27th July).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low. A long-period C7.4 flare was observed at 23/1457UTC, with this associated with a Type IV radio burst and a Coronal Mass Ejection (CME) from AR3376 in the northwest quadrant, with a partial halo on coronagraphs. This feature has been modelled, with a glancing blow possible around the turn of the UTC day 26 into 27 July. Another drawn out flare signature, peaked at C9.0 at 24/0427 UTC from AR3372, with a filament lift off possible to the south of this, however no CME is yet visible in the available coronagraph imagery.
There are currently eight sunspot regions on the visible disc, with the new region (Bxo/Beta) in the southwest being numbered AR3381 in this period. The largest region AR3372 is now approaching the northwest limb. It is becoming increasingly difficult to discern, but appears to have lost its trailing spots and is now classified Hhx/Alpha. The next largest region is AR3377 in the southwest, but this appears to be a mature stable feature and remains unchanged. AR3373, in the northwest is the most complex region on the disc and is of moderate size, however this has continued to decay slightly and is now classified Eai/Beta-Gamma. AR3379 in the northeast is also in Beta-Gamma formation but is a more open region and again shows signs of some slight decay. AR3380 in the far southwest is becoming clearer to view as it rotates further onto the visible disc, it is now classified Dao/Beta-Gamma. All other regions on the disc remain small or simple.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR at L1, suggests connection to a weak high speed stream, most likely from coronal hole 26 which is currently indistinct on the southwestern limb. Solar wind speeds were consequently slightly elevated, between 400 and 480km/s. The solar wind density was level and generally below average (<5ppcc), while the IMF was steady at 5-7nT. The north-south component ranged from +4 to -6nT, with a gradual drift from mainly anti-aligned to mainly co-aligned (with Earth's field) observed. The phi angle was predominantly negative (towards the Sun). Resultant geomagnetic activity was Quiet to Unsettled (Kp 1-3).

Energetic Particles / Solar Radiation: GOES16 high energy proton flux (greater than 10MeV) was at Background levels.
GOES16 high energy (greater than 2MeV) electron flux was mainly at Normal Background levels. 24-hour integrated fluence remained well below the Active threshold, with a slight rising trend. 4.2e6 integrated pfu, was observed at 24/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity carries a daily Chance of isolated M-class flares, most likely from AR3373, which should leave the disc midweek. Far side soundings suggest possible returning regions from around the same time though.

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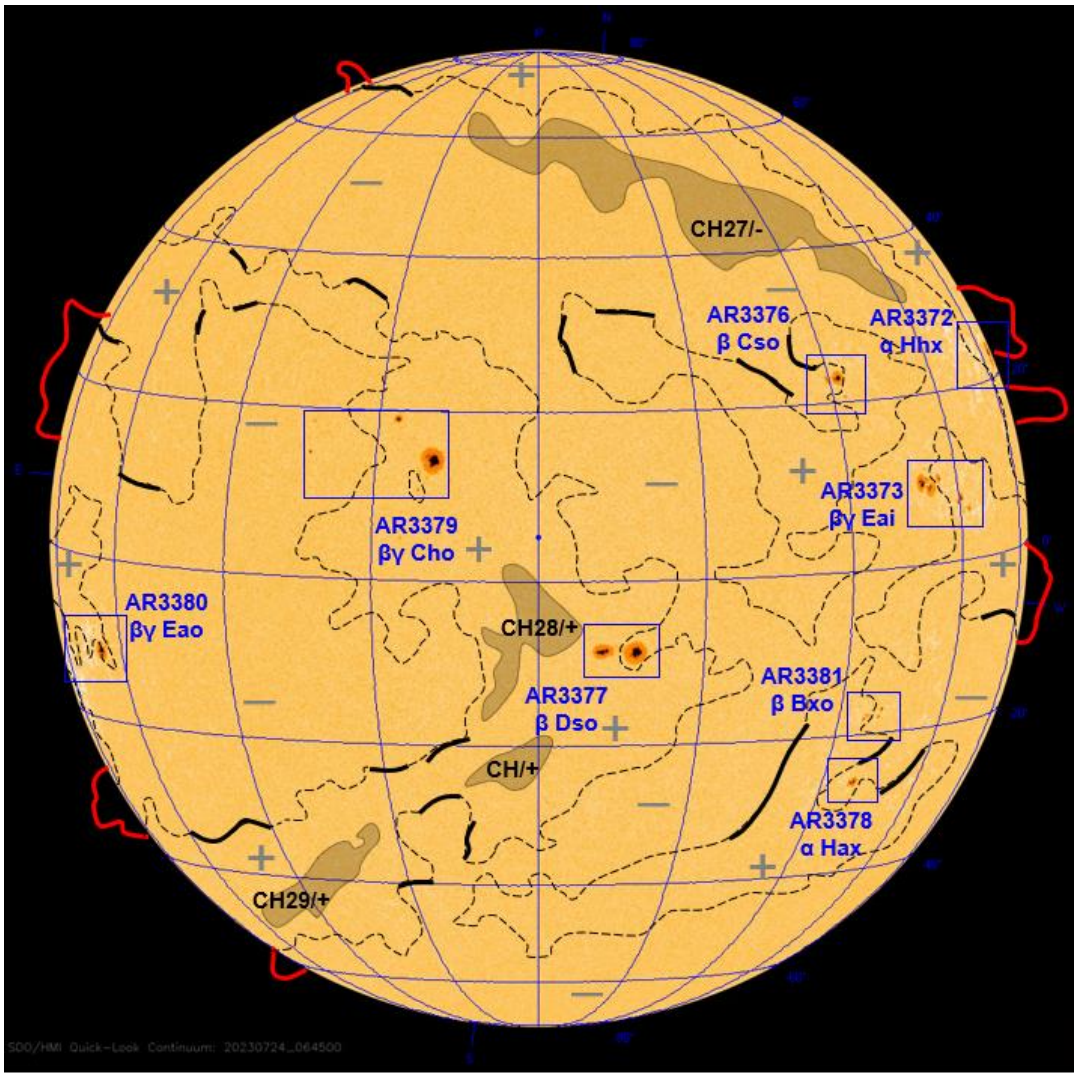
Solar Wind / Geomagnetic Activity: A glancing blow from the 23 July C7.4 CME from AR3376 is possible around the turn of the UTC day of 26 into 27 July. This brings a Chance of G1 should it affect Earth. Otherwise, a further high speed stream from coronal hole 27 is forecast to connect with the Earth during 24 July.
Mainly Quiet to Unsettled geomagnetic activity is expected, with a Slight Chance (10%) of a G1/Minor Storm from coronal hole 27 on day 1 (24th), and a Chance (30%) of G1 should the CME from AR3376 affect Earth late on the 26th into the 27th July.

Energetic Particles / Solar Radiation: The high energy (greater than 10MeV) proton flux is expected to persist at Background levels, with a daily Slight Chance of an S1+ event, falling slightly as some of the more potent regions begin to rotate away onto the far side later in the period.
The high energy electron flux (greater than 2MeV) is currently at Normal Background levels, with a chance of rising to High at diurnal peaks from day 2 (25th), The associated 24-hour fluence carries a Chance of breaching the Active threshold rising by midweek.

Figure 1. Solar Analysis Valid 24/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

AR3376 produced a long-period C7.4 flare at 23/1457UTC (perhaps contributed to by a concurrent flare from AR3380). This produced a partial halo CME that has been assessed and modelled as presenting a risk of a glancing blow around the turn of the UTC day 26 into 27 July. The main part of the CME is modelled as crossing 1AU around 26/1200UTC, however because a glancing blow from the side lobe of the CME is forecast, a considerable delay is likely, with a most likely arrival of 27/0001UTC +/-6 hours. MOSWOC Enlil is currently providing a reasonable assessment of current solar wind conditions, although it does suggest possible interaction with a CIR - perhaps that from CH28/+ near centre disc. While this aspect lowers confidence as to the magnitude of any impact, no timing adjustment is felt necessary. This is the only CME that features.
Otherwise, slightly elevated solar winds may become further enhanced during 24 July, due to connection with a high speed stream from coronal hole 27 in the northern hemisphere. This produced speeds of around 450-550km/s on the last rotation, with a similar enhancement likely on this occasion. Winds are then forecast to ease later on the 26th into the 27th July as these effects wane.
Generally geomagnetic activity is forecast to be mainly Quiet to Unsettled, with a chance of Active intervals on Monday 24 July from CH27, and a slight chance of G1/Minor Storm. Later on day 3 (26th) into day 4 (27th), if the CME arrives then activity is likely to increase to Unsettled to Active, with a chance of G1.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	1	10	30
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
23/1915 UTC	Partial	AR3376	NW quadrant	735 km/s	27/0001 +/- 6 hrs	Glancing blow

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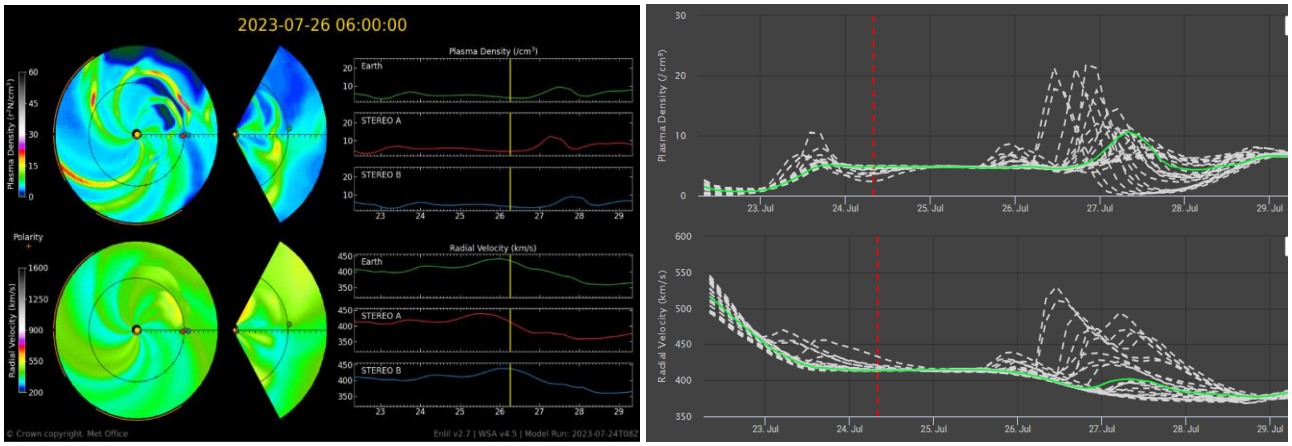
Figure 2: Latest MOSWOC Enlil run with Ensemble, showing possible CME arrival late 26th into 27th July.



Radio Blackouts - X-Ray Flares:

While there are up to eight sunspot groups on the current Earth-facing disc, the majority are either simple and stable or in slow decay, as appears to be the case with AR3373, AR3372 and AR3379. There has been a trend over recent days away from Zurich D, E, and F groups towards simpler C groups, and this has had a knock-on effect on the raw values for flares from the disc.
AR3380 in the far southwest is becoming clearer to view as it rotates further onto the visible disc and is looking increasingly complexed, now classified Dao/Beta-Gamma, so this may offset some of the decay and the losses over the western limb. Firstly AR3372 is due to depart by 25 July, but most notably AR3373 which should leave the disc by midweek. Far-side soundings suggest that the bulk of potential active regions lie east of Carrington longitude 090, which is at least two days' rotation away from the eastern limb. While their presence is uncertain (perhaps being plage), these may also serve to offset some of the losses later in the period.
All considered, there is a daily Chance of isolated M-class flares and a very slight chance of an X-flare, with the most likely source remaining AR3373.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	40	40	40	30
Very Active	R3 to R5 X Class	No	5	5	5	5

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Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux, as observed by GOES16, is now at Background levels after recent enhancements.
There is an ongoing Slight Chance of reaching the S1/Minor Radiation Storm threshold should a sizeable flare occur in AR3372 or perhaps more likely AR3373, although the trend in both spots appears to be towards simplification and shrinking. The daily risk of proton events should begin to wane as this pair begin to rotate away onto the far-side later in the period.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	10	10	10	5
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electrons (greater than 2MeV) are at mainly Normal Background levels in a modest fast solar wind environment. The forecast upcoming high speed stream from CH27 is likely to lead to a rise in flux levels, with a chance of exceeding the High (1e3pfu) threshold from day 2 (25th).
24-hour electron fluence is most likely to remain below the Active (1e8 integrated pfu) threshold throughout the period, although a rising trend is expected. MOSWOC REFM indicates this rising tendency, with the previous rotation eventually seeing narrow exceedance of Active, although due to the slightly damped response to CH26 on this rotation and CH27's diffuse appearance, on balance 24-hour fluence is felt to more likely trend slightly below last pass by midweek.
In addition to the above, any CME influence may dent 24-hour integrated fluence at GEO on day four.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	10	30	20
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

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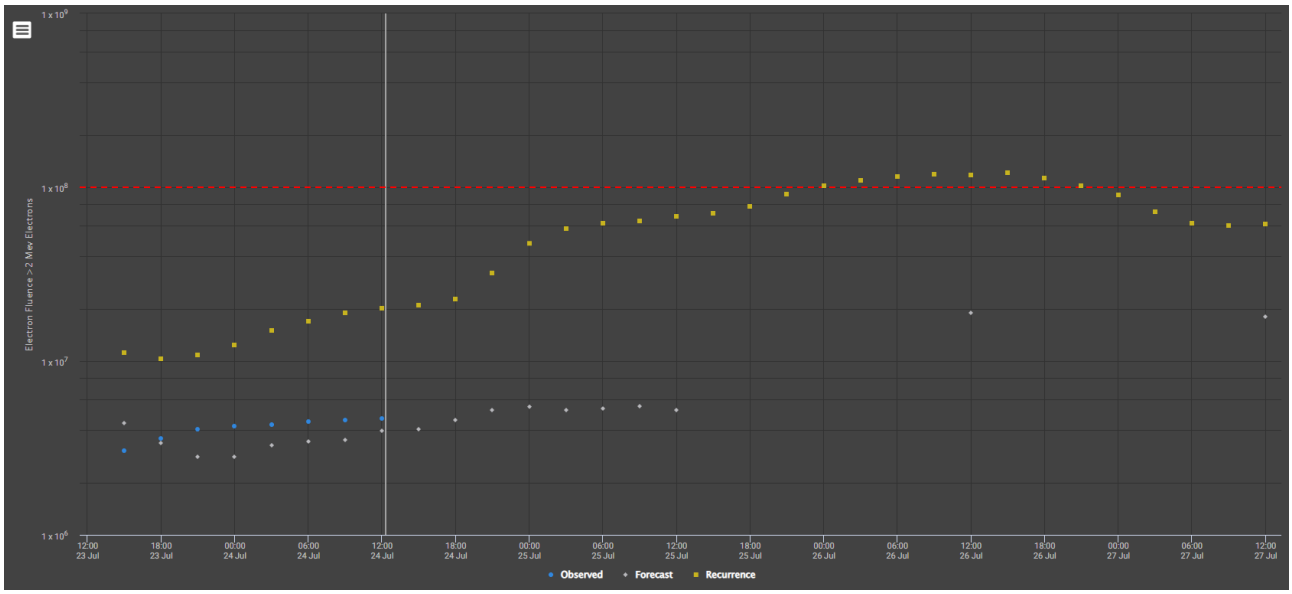
Figure 3: Observed GOES16 electron fluence, plus REFM and recurrence data.



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